

WHAT IS CLAIMED IS:

1. An optical imaging system comprising:

5 a rod lens array comprising a plurality of rod lenses having a refractive index distribution in a radial direction that are arranged in two rows with their optical axes in parallel, and  
a manuscript plane and an image plane that are located on opposite sides of the rod lens array,

wherein the refractive index distribution of the rod lenses is  
10 expressed by

$$\text{Eq. 1 } n(r)^2 = n_0^2 \cdot \{1 - (g \cdot r)^2 + h_4 \cdot (g \cdot r)^4 + h_6 \cdot (g \cdot r)^6 + h_8 \cdot (g \cdot r)^8\}$$

where  $r$  is a radial distance from an optical axis of the rod lenses,  $n_0$  is a  
15 refractive index on the optical axis of the rod lenses, and  $g$ ,  $h_4$ ,  $h_6$  and  $h_8$  are refractive index distribution coefficients,

the refractive index distribution coefficients  $h_4$ ,  $h_6$  and  $h_8$  are on a spheroid in a Cartesian coordinate system with  $h_4$  being  $x$ -axis,  $h_6$  being  
20  $y$ -axis and  $h_8$  being  $z$ -axis, and

the spheroid is defined by a vector  $X^*$  that is expressed by

$$\text{Eq. 2 } X^* = (x, y, z) = O^* + k_A A^* + k_B B^* + k_C C^*$$

where  $O^*$  is a vector from an origin of the Cartesian coordinate system to a  
25 center of the spheroid,  $A^*$ ,  $B^*$  and  $C^*$  are vectors in the directions of a major axis, a mean axis and a minor axis of the spheroid, respectively, and  $k_A$ ,  $k_B$  and  $k_C$  satisfy  $k_A^2 + k_B^2 + k_C^2 \leq 1$ .

2. The optical imaging system according to claim 1, wherein  $k_A$ ,  $k_B$  and  
30  $k_C$  satisfy

$$\text{Eq. 3 } k_A^2 + k_B^2 + k_C^2 \leq 0.7.$$

3. The optical imaging system according to claim 1, wherein the  
35 refractive index  $n_0$  on the optical axis of the rod lenses is in a range of  $1.4 \leq n_0 \leq 1.8$ .

4. The optical imaging system according to claim 1, wherein a product  $g \cdot r_0$  of the refractive index distribution coefficient  $g$  and a radius  $r_0$  of a portion of each rod lens functioning as a lens is in a range of  $0.04 \leq g \cdot r_0 \leq 0.27$ .

5. The optical imaging system according to claim 1, wherein the refractive index distribution of the rod lenses is expressed by

$$\text{Eq. 4} \quad n(r)^2 = n_0^2 \cdot \{1 - (g \cdot r)^2 + f(r)\}$$

where  $f(r)$  is a function of  $r$ , and the  $f(r)$  satisfies

$$\text{Eq. 5} \quad h_{4A} \cdot (g \cdot r)^4 + h_{6A} \cdot (g \cdot r)^6 + h_{8A} \cdot (g \cdot r)^8 \leq f(r) \leq h_{4B} \cdot (g \cdot r)^4 + h_{6B} \cdot (g \cdot r)^6 + h_{8B} \cdot (g \cdot r)^8$$

for  $r$  in a range of  $0 \leq r \leq r_0$  ( $r_0$ : a radius of a portion of each rod lens functioning as a lens) with respect to two groups of refractive index distribution coefficients ( $n_0, g, h_{4A}, h_{6A}, h_{8A}$ ) and ( $n_0, g, h_{4B}, h_{6B}, h_{8B}$ ) that are in the ranges determined by Equation 2.

6. The optical imaging system according to claim 1, wherein a radius  $r_0$  of a portion of each rod lens functioning as a lens is in a range of  $0.05 \text{ mm} \leq r_0 \leq 0.60 \text{ mm}$ .

7. The optical imaging system according to claim 1, wherein  $r_0/R$  is in a range of  $0.5 \leq r_0/R \leq 1.0$ , where  $r_0$  is a radius of a portion of each rod lens functioning as a lens and  $2R$  is a distance between the optical axes of two neighboring rod lenses.

8. The optical imaging system according to claim 1, wherein  $Z_0/P$  is in a range of  $0.5 \leq Z_0/P \leq 1.0$ , where  $Z_0$  is a length of the rod lenses and  $P = 2\pi/g$  is a one-pitch length of the rod lenses.

9. The optical imaging system according to claim 1, wherein an overlapping degree  $m$  is in a range of  $0.9 \leq m \leq 5.0$ , and the overlapping degree  $m$  is given by  $m = X_0/2r_0$ , where  $r_0$  is a radius of a portion of each rod lens functioning as a lens and  $X_0$  is an image radius that the rod lens

projects onto the image plane.

10. The optical imaging system according to claim 1, wherein a parallel  
plane transparent substrate is arranged so that the manuscript plane is  
5 located at a front focal position of the rod lens array.

11. The optical imaging system according to claim 10, wherein the  
parallel plane transparent substrate is in contact with a lens surface of the  
rod lens array.  
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